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THE BOTANICAL GAZETTE

EDITORS:

JOHN M. COULTER, Lake Forest University, Lake Forest, Ill.
CHARLES R. BARNES, University of Wisconsin, Madison, Wis.
J. C. ARTHUR, Purdue University, Lafayette, Ind.

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In the October number will appear:

The regulatory formation of mechanical tissue, by DR. F. C. NEWCOMBE, which is in type, but is crowded out of the present issue.

Synopsis of North American Amaranthaceæ. IV, by EDWIN B. ULINE and WM. L. BRAY, *Lake Forest University.*

New or peculiar aquatic fungi. I, Monoblepharis, by DR. ROLAND THAXTER, *Harvard University.*

Noteworthy anatomical and physiological researches.

BOTANICAL GAZETTE

SEPTEMBER, 1895.

Development of Vegetable Physiology.[1]

J. C. ARTHUR.

There is a certain fitness in bringing before the section of this Association which has been most recently established some account of that department of botanical science which is one of the latest to be brought into notice as a grand division of the subject. For vegetable physiology, the topic which is to engage our attention, is like a western or African domain, long inhabited at the more accessible points, more or less explored over the larger portion, but with undefined boundaries in some directions, and with rich and important regions for some time known to the explorer, but only now coming to the attention of the general public. In fact, our domain of vegetable physiology is found to be a diversified one, in some parts by the application of chemical and physical methods yielding rich gold and gems, in other parts coming nearer to every man's daily interests with its fruits and grains. Thus it comes about that, before the public is well acquainted with the name of the science, it has differentiated itself into two or three sciences, having quite separate objects in view.

It is the purpose of this address to acquaint you with the growth and present outlines of the group of sciences, which, for convenience, are included under the heading of vegetable physiology, and also to show why they deserve recognition as important constituents of a liberal education along with other natural sciences. The point of view at all times will be that of the American botanist.

In the development of botany in America the science has passed through successive waves or stages of popularity, constantly increasing in momentum, widening its scope by evo-

[1] Vice-presidential address before section G, A. A. A. S., Springfield meeting, August 29, 1895.

lution of new interests, and more and more exhibiting virility by its adaptability to the needs of the times. That botany has in it something that may be transmuted into money has only recently been discovered, but it is a discovery that is likely to work benefit not only to the practical man who makes application of scientific truths to commercial ends, but also reciprocally to the investigator who thinks only of uncovering a new fact or establishing a new law. To adequately meet the requirements of modern botany in the way of laboratories, gardens, herbaria, libraries and apparatus, requires a capital that not long since would have been deemed fabulous. The money to meet this demand of a growing science must be expected to come in the main as the voluntary contribution of an interested public, the reciprocal response to the attitude of botany toward the general welfare.

I have mentioned the economic aspect of botany thus early, because it is one of the significant changes which has come over the science within the last decade or two, and to which vegetable physiology in some of its features is, I venture to say, about to add further important contributions. Science no longer shrinks into the shadow of the closet for fear of being implored to lend a hand at securing revenue, but steps forth and curiously scrutinizes every process of the practical world, often finding there its most fruitful fields for fundamental research.

The problems of vegetable physiology possess to a greater or less degree a special element of interest not inherent in those of other departments of botanical science. They embrace the dynamical property of motion, which never fails to exercise a fascination over the human mind. Physiology, in fact, deals with what plants do, their methods of activity, their behavior; while the other divisions of botany treat of what plants are, or have been, their form, structure, and relation of parts. The one is the study of the organic machine in action, and the other the contemplation of its component members.

Movement in plants does not attain the rapidity exhibited by animals. Some movements in both cases are ultra-visual, as the translocation of molecules in metabolism, the diffusion of gases, and in plants especially the flow of liquids. In plants even the movements of the organs are comparatively slow. While the leaves of the sensitive plant, telegraph plant, and

Venus's fly-trap, and the petals of certain orchids excite the wonder of the casual beholder, most plant organs move too slowly to be readily detected without mechanical magnification. This does not prove a detraction to the interest of the subject, however, as it has led to the invention of ingenious and complicated machines, whose numerous wheels and bands inspire a sense of importance, particularly appealing to a large class of persons in this age of machinery, and constituting an element in securing favorable attention from the public, while it adds a charm to the work of the investigator, rivaling that of the microscope. It is yet but the dawning of day for the display of mechanical contrivances as aids to botanical research, and the future gives promise of notable achievements. The names of Barnes, Anderson, Stevens, Stone, Golden, Thomas, Frost, and Arthur at present are representative of the American inventive spirit in botany. The most perfect and interesting pieces of apparatus yet turned out by them embrace Frost's and Golden's auxanometers for recording the increase in length or thickness of growing organs, Thomas's apparatus for recording the variation in pressure of sap resulting from root action, Anderson's automatic balance for registering the rate and amount of change in the weight of an object, used in studying transpiration and growth, and Arthur's clinostat for neutralizing the action of gravity and light, and his centrifugal apparatus for substituting mechanical force for that of gravity.

While having in mind the public interest in our science, it may be well to notice the very small basis of information on which this interest is founded. Only the vaguest notions are current regarding the nutrition of plants, the uses of the leaves, the movements of sap, the purposes of color, and the means by which new positions are assumed. This ignorance is primarily due, of course, to the same cause which has so long delayed the development of the science upon the technical side: the fact that almost nothing can be learned of the functions of plants from direct observation. In regard to the physiology of animals, even the lowest, much may be inferred by observing their behavior, and analyzing the phenomena from a human standpoint, but there are no obvious similarities between plants and the higher animals, and it is necessary to resort to careful experimentation and profound study to arrive at a fair understanding of the vital actions of plants.

Physiology is an experimental science, and the public must perforce derive its knowledge second hand without much opportunity of verification. It must be admitted that, although a view of this portion of the *res publica naturæ* has its fascination, yet the attainment of vantage ground for the survey is necessarily difficult and slow.

The term public, when used in connection with vegetable physiology, needs to be construed liberally. It will include, without doubt, some able scientists and men of liberal education. I may be permitted to cite an occurrence to which some in this audience were witnesses. Some time since the subject of gases in plants was before the Association and induced an animated discussion. Probably half of those participating confounded respiration, which is a general function of all plants, as well as animals, under all conditions of existence, with the photosyntactic function of fixation of carbon by the green parts of plants in the presence of sunlight. Both processes have to do with oxygen and carbon dioxide, but the resemblance goes no further. It is an error dating back to the last century, when the two processes were discovered, and one for which botanists themselves are by no means without responsibility. Another error not yet dislodged from the cobwebby corners of many a well-read man's intellectual storehouse is the old fiction of a circulation of sap, so dear to those who desire to find analogies in plants with the physiological processes of animals. It is not much over fifty years since the learned French Academy exhibited its ignorance of vegetable physiology by awarding the grand prize to an essay founded upon this error; and the error still lives.

But the general ignorance of even the best established and most readily apprehended facts of physiology may be justly extenuated when the pedagogical status of the subject is examined. Botany, as a substantial part of the curriculum, cannot be said to have received recognized standing in the American educational system until the time of Asa Gray. In the latter part of the decade of the thirties his first text-book, the "Elements of Botany," appeared, and in the decade following the "Text-book for Colleges" and the "Manual," all of which works showed a true appreciation of the best features of the science and the needs of the time. They were so well conceived, and so much in demand, that new editions rapidly succeeded one another; and to the present day they hold a

high place in the estimation of botanical teachers. These works possessed a specially potent element of virility in being the expression of knowledge at first hand, the words of the master. In so far as inspiration was drawn from foreign sources it came chiefly from French and English scholars, of whom De Candolle the eldest and Robert Brown were the representatives.

A half century ago vegetable physiology, in the fulness of the modern meaning of the words, did not exist. Structural botany was then the dominant phase, and in elementary instruction took the shape of close attention to the form and arrangement of the organs of flowering plants, with the ulterior object of being able readily to determine the names of the plants of the field. Even then physiology presented some attractive features, but they appeared largely extra-territorial, as the title of the book from which most of us received our early botanical pabulum testifies: "First Lessons in Botany *and* Vegetable Physiology," by Asa Gray, issued in 1857, and continuing its supremacy as a text-book until 1887, when it was revised and renamed.

In the seventies botanical laboratories began to form a necessary feature of the best institutions, each with its quota of compound microscopes and reagents, in which we followed the example of Germany, such laboratories having been established at Halle, Breslau, Munich and Jena a decade previous, and subsequently at many other centres of learning. With the advent of Sachs's "Text-book of Botany" in English dress about this time, the science in America took on a new and vigorous phase of development. The method of this work found more convenient expression in Bessey's "Botany" (1880), which for a decade was the recognized standard of instruction. A wealth of laboratory guides soon appeared, and American botanists became devotees of microscopic anatomy. I scarcely need call your attention to the triumphal advancement of botany during the decade of the eighties, it is so fresh in every one's mind. It amounted to a revolution; the work of the herbarium was wellnigh abandoned for the study of the cell. Those of the older systematic botanists who took no part in this upheaval became alarmed, and put forth vigorous protests, claiming with much justice that pupils so trained lost breadth of view and proper perspective. An editorial writer in the BOTANICAL GAZETTE very clearly

contrasted the two methods of instruction. "The ancient method," said he, "gives a wide range of acquaintance with external forms, a general knowledge of the plant kingdom and its affinities, a living interest in the surrounding flora; but it disregards the underlying morphology of minute structures and chemical processes, the great principles which bring plant life into one organic whole. The modern method, on the contrary," he continues, "takes a few types, carefully examines their minutest structures and life work, and grounds well in general biological principles; but it loses the relation of things, as well as any knowledge of the display of the plant kingdom in its endless diversity, and, worse than all for the naturalist, cultivates no love for a flora at hand and inviting attention. The former is the method of the field, the latter of the laboratory."

But under both ancient and modern methods of instruction, whether the teacher were a systematist or histologist, whether the pupil pulled apart flowers under a hand lens, or dissected tissues under a compound microscope, botany flourished in America. There was, in reality, a better philosophy abroad than usually appeared in practice. The layman, remembering his school days, might assert with Julian Hawthorne that "botany is a sequel of murder and a chronicle of the dead," but the professional botanist, imbued with the spirit of the times, resented the imputation as no fault of the science; and while deploring the well enough known mediævalism and incompetence of teachers, who only disclosed a descriptive and classificatory science, with marvelous wealth of terminology to be sure, but as lifeless and unbiological as mathematics or astronomy, pointed to the motto held by all the progressionists, "the study of the plants as living things."

The revivifying spirit which was pervading the botanical world, which strove to find in plants more than objects for the glossologist and the cataloguer, which interrogated the plant upon matters of action as if a dumb intelligence, which diffused a new light and a higher significance into every fact of the science, had its source in that all-pervading influence which emanated from the observations and interpretations of Charles Darwin. The brilliant series of works upon the behavior and relationship of plants by this author, beginning with the fertilization of orchids in 1862 and extending through a score of years, left a profound impress upon botanical

thought, based as they were upon the connecting thread of evolution. So different now was the point of view that there sprang up what was called the "new botany." Although the inspiration of the "new botany" was general, yet it manifested itself pedagogically chiefly in elementary instruction and in special studies. We may pass the delightful brochure of Asa Gray on "How Plants Behave" (1872) with a bare mention, as it appeared too early to show any peculiarities of method not familiar to the readers of Darwin, and call to mind the much less pretentious presentation of the new way as understood by Beal under the title of "The New Botany" (1881). He declares it to be a study of "objects before books," in which "the pupil is directed and set to thinking, investigating, and experimenting for himself." The new method did not fit equally well into all departments of botany, and found its best expression for the most part in developmental and physiological subjects. It was in fact the chief agent in preparing the ground for the crop of physiology that is now being sown, and sown in a field selected and staked out by Darwin and Sachs.

Having shown how the field for the reception of the latest botanical husbandry was prepared, I may now briefly trace the source of the ideas with which it was implanted, and in doing so it is necessary to point out that vegetable physiology, as the term is generally employed, is not a homogeneous science.

The advancement of any subject is promoted by a clear understanding of its outlines, and it is in the interest of clear concepts and convenient usage that certain natural limitations should be respected by physiologists. Not that intergradation and mutual dependence do not occur, but that certain natural boundaries may be more or less distinctly recognized which will throw the subject matter into sections and simplify the presentation of the numerous facts of the science.

The most obvious distinction to be made in the physiological aspect of organisms is in regard to their maturity. The organism in its embryonic or juvenile condition manifests functional peculiarities of the highest import, quite unlike those of the adult. The physiology of reproduction belongs here, and includes not only a study of the formation and increase of the young plant, that is, embryology, but genesiology as well, that is, the philosophy of the transmission of

qualities and powers from the parent to the offspring, both in vegetative and sexual reproduction. It is a curious fact, to which Vines has recently called attention, that even vegetative reproduction, as in the case of the growth of a plant from a cutting, brings about rejuvenescence of the protoplasm, the new individual showing the characters of youth, and not of maturity. In both sexual and asexual reproduction the attention should be focused chiefly upon the behavior of the cell, and a wonderful complexity will be found in these minute structures. The mystery of a world is bound up in this bit of protoplasm, and corresponding to the *multum in parvo* aggregation of properties there seems to be an unsolved intricacy of structure. By the study of what was originally supposed to be essentially homogeneous protoplasm, we have gradually distributed and extended the properties of the cell to the cytoplasm, the plastids, the nucleus, the nucleoli, the fibrillar network, the chromosomes, the centrosomes, the kinoplasmic spindle, and the polar bodies. What further distribution of function will eventually be found, it is too early in the history of investigation to prognosticate.

But it is not every dividing cell that points the way to a new individual. Plants with complex structures possess tissues of embryonic character, such as the cambium, whose utmost power of division only leads to the production of additional tissues like those adjoining it, but are wholly incapable of originating a new individual, or even a new organ. From this histogenic extreme all gradations and variations occur, to the perfectly reproductive spore, which by its growth forms another individual without contributing anything to the support of the parent organism.

Beside the elementary riddles of life bound up in the processes of cellular reproduction, or cytiogenesis, there are others relating to nutrition, growth, and irritability, which comprise what animal physiologists group under the term "cellular physiology," for which Professor Verworn, of Jena, made such an impassioned plea in the *Monist* about a year ago. "We find," said he, "that even the minutest cell exhibits all the elementary phenomena of life, that it breathes and takes nourishment, that it grows and propagates itself, that it moves and reacts against stimuli," and therefore he urged that far more attention should be given to this department of physiology, as the key to many complicated processes. The physiological

study of the cell, including both its reproductive and vegetative aspects, in so far as they may be considered the nascent functions of the elementary parts of the organisms, may be conveniently considered under a single heading, "caliology."

Passing to the physiology of the adult organism, a little reflection will show that the activities of the plant may be considered from two standpoints: that of the plant's individual economy, and that of the plant's social economy, or its relation to other plants and animals and the world at large. Looking at the latter phase more closely, we shall find that the subject contains some of the most interesting topics in the range of botany, which appeal especially to the lover of nature, without losing their value as problems of the deepest scientific import. Among the relations of plants to the world at large may be mentioned the influence of climate, the means of protection against rain, drouth, and cold, adaptation to the medium in which the plant grows, and the establishment of rhythmical periods. Among the relations of plants to animals are those interesting chapters in the fertilization of flowers by insects, the contrivances by which plants with a predilection for highly nitrogenous food may capture and feed upon insects, and the means adopted by plants to prevent injury from large animals, which are more or less familiar to the general public through the writings of Charles Darwin. Among the relations of plants to one another comes foremost the struggle for existence, bringing into play the laws of natural selection and the survival of the fittest, together with much else that is now known under the head of evolution, followed by various phases of parasitism, mutualism, and other topics. Is it not evident from this hasty and by no means complete outline that here is a portion of physiology which appeals to all classes of thoughtful persons, rich in possibilities for the philosophical and speculative mind, and bristling with queries demanding experimental solution?

Although this department of physiology has received much attention here and there for a long time, and some of its topics are well understood, yet only very recently has it fallen into place as a systematic part of the general subject, and no separate presentation of it has yet appeared in English, and only two works in German. There is some confusion regarding the name of the science. The Germans call it "biology," which may serve to emphasize the importance of regarding

the plant as a living, plastic being, but it is not an exclusory term, and also does violence to its philological derivation. Even the recently proposed modification into phytobiology does not much improve the term. The English usage of the word biology, as so admirably set forth by Huxley, and more or less consistently adopted in this country, leaves no place to introduce the imperfect usage of the Germans. Two years ago, in his wholly delightful "Chapters in Modern Botany," Patrick Geddes proposed the term "bionomics." The same year, however, a better term was advocated almost simultaneously in England and America. The Madison Botanical Congress endorsed the word "ecology" as the designation of this part of physiology; and only a few days later Professor Burdon-Sanderson, in his Presidential Address before the biological section of the British Association, outlined the science and traced the origin of the name ecology, of which he made use.

Ecology, therefore, is the name under which we are to attempt the orderly arrangement of the facts, observations and deductions composing the science, in which, to quote Burdon-Sanderson, "those qualities of mind which especially distinguish the naturalist find their highest exercise." The first independent treatise on the subject is by Wiesner (Vienna, 1889), and is an excellent model, while Ludwig's work, issued a few months since (Stuttgart, 1895), which is the second and to the present time only similar work, cannot be so highly praised. A work in English is greatly to be desired.

Having disposed of the external or sociological economy of the adult plant under the heading of ecology, we turn to the consideration of the internal or individual economy. This is the portion of physiology now in the ascendency, and the part which is usually more particularly intended under the present usage of the term vegetable physiology. The tendency is to restrict the titular use of the term to this part of the subject alone, which is to be approved. This gives us three well defined departments in the science of the activities of plants; caliology, ecology, and physiology.

Physiology, in the restricted sense, deals with the most vital of problems, how the individual lives. It pertains to the way in which plants breathe, secure and use their food, adjust themselves to light, heat, moisture, and the contact of other bodies. It deals with what botanists in the days of

Linnæus, and even down to within the last fifty years, would have called the products of the *vis vitalis*. It desires to know what the specific energies of the plant are capable of accomplishing, in short, what is going on within the plant in the way of life processes. As will be readily seen, the whole matter is summed up in an exhibition of energy, which in former days was called vital energy, and thought to reside exclusively in living organisms, but now held to be only a special manifestation of the general physical forces of the universe.

The energies of plants fall into two categories, those which bring about changes in the intimate structure of vegetable substances, and those which bring about movement; and hence we call physiology a superstructure whose foundation is chemistry and physics. The present great advance in the science may, in large measure, be traced to the wonderful advances in the sciences of chemistry and physics, which have supplied facts and methods to assist the physiologist in his study of life processes.

Yet it would be an egregious mistake to suppose that physiology is but a dependency of chemistry and physics. The substitution of the so-called mechanical philosophy of life for the old vitalistic philosophy has not in any way rendered the vital activities less wonderful, or the protoplasmic display of energy less complex, less inscrutable, or less *sui generis*. The meaning of the word life shows no likelihood of being solved until the chemical and physical constitution of the protoplasmic molecule is understood, and that is too far away to make speculation at this time worth while; and so we need not quarrel with those who fancy that even when that advanced goal is reached the problem will not be solved, but a mysterious residuum will still exist to endow protoplasm with autonomy. Be that as it may, the path of present advancement keeps steadily onward in the clear light of physical laws, and ignores the nearness of mystical, unfathomable shadows.

But returning from this long digression in separating physiology into the three reasonably distinct sciences—caliology, ecology, and physiology proper—we will proceed with the inquiry regarding the present scientific status and its course of attainment in each of the three branches. It is not, however, any part of my purpose to give a philosophical or historical disquisition upon the subject, but merely to point out a few land-

marks to enable us to get our bearings, so that we may spy out the land and obtain some opinion of what there may be good or bad in it.

The subject of caliology, that is, the various phases of juvenescence, including especially the dynamics of the young cell, has not yet received systematic presentation. Although a vast array of facts has been recorded, mostly to be sure as the concomitants of morphological studies and scattered so widely as to be almost lost, yet the value of the subject as a separate inquiry has not yet much impressed itself upon botanical students. There are, doubtless, most excellent reasons for this, not in any wise dependent upon the importance or attractiveness of the subject. The action of a machine as a whole depends upon the interaction of its parts; and to fully understand its operation requires a knowledge of its mechanism. No adequate theory of the physiological processes in the mature organism was possible until the character of the cellular framework and the distribution of tissues had been well worked out: and in the investigation of cellular physiology there occurs the same inherent difficulty. The structure of the cell in all its microscopic detail must be ascertained, and when the microscope fails us, there must be well-framed theories of the physical organization of the parts, before solid advancement in understanding cellular activity can be expected.

The labors of Strasburger have been especially noteworthy in establishing an adequate morphological basis for the interpretation of cellular activity. If we were to point to a single work as particularly conspicuous in this connection, it would be his *Zellbildung und Zelltheilung* (1875), which introduced hardening and staining methods into the study of the cell, and may be said to have created a new school of histologists, even more conspicuously represented among zoologists, possibly, than among botanists. Great accuracy and a far clearer interpretation have been attained by the new methods, causing a rapid accumulation of trustworthy facts regarding the parts of the cell, especially of the reproductive cell and its neighbors, and of the succession of changes as the young organism or as the histogenic elements pass toward maturity. In this important work America can count some able investigators and valuable contributions, especially in making known the development of the metaspermic embryo and accompanying changes.

Morphological knowledge of the cell and of the stages in reproduction must necessarily be followed by inquiry into physiological processes. Already the writings of De Vries, Strasburger, Klebs, Vöchting, Wiesner, and Vines have indicated the directions for study. The greatest impulse to the physiological study of reproduction, however, has been given by Weismann, although not himself a botanist, and not drawing heavily from the botanical storehouse to support his theories. Nägeli's idioplastic theory of 1884, and De Vries's later theories, have not of themselves been sufficient to arouse botanical enthusiasm. The whole domain of caliology is suffering, in fact, for leaders, men chiefly known for their researches in this field. The science needs a Linnæus, a Sachs, or a Gray to bring it into prominence and to inspire enthusiasm and a following. Some day it will be in vogue.

Upon turning to ecology, we find the conditions wholly changed. There are elements of popularity in the science that have made some of its topics familiar to the general reader, even before the boundaries of the science have been mapped. The fascinating and epoch-making observations of Charles Darwin on the pollination of orchids and other flowers, at the same time bringing to light the long lost Pompeian-like treasures of Sprengel, gave an impulse to a line of study still full of promise. The extensive writings of Müller, Delpino, and in our own country Charles Robertson, have provided large stores of knowledge, and at the same time opened up attractive vistas for further observation.

Thus we might enumerate many other topics, which are more or less familiar to every one having the slightest acquaintance with botany, and to some others as well. If we ask how these matters came to be so widely known, the answer is not far to seek, and not obscure. The marvelous inspiration which came with the writings of Charles Darwin, and the fact that he cultivated ecological subjects more than any other, together with his theories of adaptation and natural selection which provided a key to the riddles of nature, making what were before matters of course now matters of the liveliest import, turned the attention of the botanical world, and of all other lovers of plants as well, even of some who cannot be placed in either class, in this direction. We may call Darwin the father of vegetable ecology, for had he not written, the field would have lain largely uncultivated and uninteresting.

In America the year 1887 saw the establishment of a series of state institutions, which gave a wonderful influence to the study of ecology. American botany owes much to the Agricultural Experiment Stations, especially in promoting a knowledge of vegetable pathology and ecology. Together with the Agricultural Department of the general government, they have enabled American botanists to become the leading investigators and writers upon pathological subjects, giving a position and imparting a value to the science of plant diseases, both scientific and practical, that ten years ago would have been inconceivable. What has been done for pathology is likely to be done for ecology, as it is the second subject in importance cultivated by station botanists. In the latter science the assistance of the Agricultural Colleges is also important, for in a few years the subject will undoubtedly hold a commanding position in the curriculum of the agricultural and general science courses of these institutions, and be regarded as the culminating and leading feature of a course of botanical study. It may seem presumptuous and fanciful to claim so much and be so positive in face of the fact that at the present time the subject is a *nomen incognitum* to the makers of curricula in these institutions; but careful examination of the subject matter of the science shows that even in its present rather chaotic condition it embraces more points of vital interest to the lover and cultivator of plants than other departments of botany, being less recondite, and yet at the same time underlaid with a broad and attractive philosophy. What is most needed at present is a suitable textbook; for the value of the subject will be more quickly recognized when it is displayed in well arranged form.

It would be interesting and profitable to take a survey of the development of the different branches and topics of the science, but I shall content myself with barely mentioning one or two which especially flourish in this country. Recently a new life has been infused into the study of floras and the distribution of plants by what is called the "biological" method, the inspiration having been derived in the first place from the zoologists. This method, which has so far been most successfully applied to limited areas in the western part of the United States, undertakes an explanation of the present location of forms by considering severally and collectively the various external and inherent factors promoting and restricting their

development, including the reciprocal influence of proximity. Of the names prominent in this connection, those of Coville, Trelease and Macmillan are especially worthy of mention. The last has done good service by calling attention to the significance of tension lines, in his account of the "Metaspermæ of the Minnesota Valley." There is a phase of phylogenetic study which has received some attention of late, in form of the breeding of plants. It is a subject especially adapted to experiment station work. The leader in this line of research, L. H. Bailey, has also materially promoted ecological studies by his numerous biogenetic and other writings.

Coming to physiology, *sensu stricto*, we find the domain of the science so well defined and its several areas so well cultivated that a clear statement of its main problems is now possible. Not much advancement was made before the beginning of the present century. The most notable achievements had been the publication of Hales's brilliant work on the pressure and movement of sap, which introduced the physical side of physiology to the world, and Ingenhousz's equally entertaining volume upon his discoveries regarding the uses of green organs, which introduced the chemical side of physiology to the world. The century was ushered in by Knight's classical essays, in which it was first pointed out, among other things, that there was a substantial reason why roots grow downward and stems upward, and by De Saussure's researches upon respiration and other chemico-physiological matters. It is worth mention that Hales, Ingenhousz, Knight and De Saussure were not botanists, although they cultivated botanical subjects; neither were Senebier, Du Hamel, Dutrochet, Liebig, Boussingault and others, who assisted in laying the foundations of the science, but were physicists, chemists and horticulturists. And to this day many important data are contributed to the science by workers in other fields.

Thus facts accumulated, important discoveries were made, and the mysteries of the life processes in plants were gradually unfolded. But it was not until 1865 that the science was given the commanding position due to it. Then appeared the first treatise which set forth the phenomena and laws of vital processes with due regard to proportion, and with clear philosophical insight. Sachs, in his "Experimental Physiology," became the founder of the science in its modern aspect. He set forth with critical discrimination the most important

matters pertaining to the organism's relation to light, heat, electricity and gravity, the processes of metabolism, nutrition and respiration, and the movement of water and gases in the plant. With rare foresight he excluded all, or nearly all, topics not strictly belonging within the true scope of the science, and presented the whole subject matter in an entirely original form, breaking away from the customs of his predecessors and adopting advanced scientific methods. It was an epoch-making book. As Strasburger has recently said in his history of botany in Germany, "the work at once restored vegetable physiology to its place at the centre of scientific research."

The book has never been translated into English, and so, while it stimulated the study of physiology in Germany, and physiological laboratories soon became common, led by the famous one at Würzburg presided over by Sachs, American botany felt little of the new movement until the appearance of Sachs's "Text-book" in English dress a decade later. Even then the new science (for such it was in America) gained but an insecure footing. After another decade, in 1885, appeared the first, and to the present the only, treatise on physiological botany by an American author. This was written by Goodale in response to the desire of Asa Gray to have the several parts of his "Text-book for Colleges" expanded into separate treatises, in order to more fully represent the status of botanical science. As late as 1872 Dr. Gray contemplated writing the work himself, but, his time proving insufficient, he assigned the task to his worthy colleague. The title is used in its broad sense, and included histological anatomy, ecology, and caliology, as well as physiology proper, the last being by no means the most conspicuous part of the book. The encyclopedic fulness of the work better adapted it for a reference book to accompany a course of lectures than as a text book. It greatly helped the science in America, however, especially as it stimulated experimental study by a set of laboratory exercises given as an appendix. The year following appeared Vines's "Physiology of Plants," in some respects the most philosophical and well-digested presentation of the science yet written in any language; and only a year later still came Sachs's new treatise on the same subject. These two works were too bulky to serve well as text books for undergraduate students, but were a source of inspiration to

maturer students and to investigators. The present year, completing the third decade since the physiological epoch began, has seen the altogether admirable, although brief, account of the science by Vines, forming part of his "Text book of Botany" and two excellent laboratory manuals, one by Darwin and Acton of England, and the other an English adaptation by MacDougal of a German work. With these treatises elementary instruction is well provided for, and their effect is already seen in the rapid introduction of the study as a portion of botanical instruction in colleges, and even high schools, throughout the country.

Thus far only the pedagogical side of the science has been brought prominently forward; but what can we say of the research side? So far as America is concerned, there is no research side; the science is equipped and expanded with facts and theories from foreign sources. A few papers embodying original investigations have been published by American teachers, but they were the result of studies carried on in German laboratories. A dozen or two papers have, indeed, been issued from our own laboratories within the last five years, but all of them have been the work of students, mostly in preparation for a degree. America has nothing to show that can in any wise compare with the important discoveries made and still being made by Francis Darwin in England, De Vries in Holland, Wiesner in Austria, or Sachs, Pfeffer, Vöchting, Frank, and others in Germany. There are ample reasons why this state of things need not be considered humiliating, and yet it is to be deplored as most unfortunate.

Let us turn to a hasty examination of some of the problems of physiology which await solution. They stand out prominently in every chapter of the science, and suggest to the scientific mind most tempting opportunities for original investigation. The nutrition of plants is so imperfectly understood that it may appropriately be said to be a bundle of problems. So little do we know of the processes that even what constitutes the plant's food is in doubt. We know, for instance, that lime and magnesia are taken into the plant, but whether they are directly nutritive by becoming part of living molecules, or whether they serve as aids to nutritive processes, or become the means of disposing of waste materials within the organism, cannot be definitely stated. And to a greater or

less extent similar conditions exist respecting potassium, phosphorus, sulphur, iron, and chlorine, which in fact embrace all the so-called mineral elements of plants. The movements and transformations of the two most characteristic elements of organic structures, carbon and nitrogen, are a little better known. Some progress has been made in tracing the steps by which the simple molecule of carbon dioxide derived from the atmosphere is built up into the complex, organic molecule of starch. But the further process by which the starch molecule combines with others to form the most complex and important of all plant substances, protoplasm, is yet an almost complete mystery. The story of the progress of discovery in ascertaining the means by which plants get their nitrogen is a fascinating one, and is not yet ended. These matters in part lie at the very foundation of the most fundamental of industries, agriculture. Intensive farming, and the highest success in the raising of all kinds of crops, is greatly promoted by a knowledge of the nutritive processes in plants. The botanists, who thirty-five years ago demonstrated that carbon was taken into the plant through the leaves, and not to any material extent through the roots, struck a theme that revolutionized agricultural practice and added greatly to the wealth of the world. The more recent discovery of the connection of symbionts with leguminous and some other plants, by which the abundant supply of nitrogen in the air is converted into food available for higher plants, has also greatly affected agricultural practice. The whole subject of the nutrition of plants is so bound up with intelligent farming and all manner of plant cultivation that advancement of this part of physiology means an increase in material prosperity as well as in scientific knowledge. Ample provision for its prosecution would be a valuable investment for any people, and particularly so for the people of the United States.

There are many ways in which plants show similar physiological processes to those of animals; and plants being simpler in organization, their study may often be made to promote a knowledge of animal physiology. The greatest similarity between the two kingdoms lies in various phases of nutrition, respiration, and reproduction. The greatest divergence is to be found in the manifestation of irritability. Those fundamental processes upon which being and continued existence depend are much the same throughout animate nature, but

the processes by which the organism communicates with the world outside of itself, and through which it is enabled to adjust itself to environmental conditions, the processes which in their highest development are known as sensations, have attained great differentiation, running along essentially different lines of development. The prevalent view that plants occupy an intermediate position between the mineral and the animal kingdoms is not true in any important respect. Neither is it true that the faculties of animals, especially of the lower animals, are foreshadowed in plants. No just conception of animate nature can be obtained by conceiving it to lie in a single ascending series. It constitutes two diverging and branching series, like the blades and stems in a tuft of grass, which we may assume have been derived from a common germ. There are two fundamental characters which manifested themselves early in phylogenetic development, one structural and one physiological. The structural character of the histologic integument of the organism, in animals soft and highly elastic, in plants firm and but slightly elastic, gave rise to the two series of forms, structurally considered, which we call animals and plants. The physiological character of free locomotion for most animals and a fixed position for most plants, determined the line of separation for the development of those powers of the organism classed as irritability and sensation. So great have been the differences which these fundamental characters have brought about, that the stimulating action of external agents, such as light, heat, and gravity, have produced very diverse powers in the two kingdoms. Animals have a wonderful mechanism which enables them to see, while plants have a no less wonderfully specialized sensitiveness by which they assume various positions to secure more or less illumination. Animals have a sense of equipoise, but plants have a very dissimilar and even more remarkable sense of verticality. And so on throughout the list of stimuli, the reactions are not the same, but are differentiated along entirely separate and divergent lines. The period is fortunately well past when physiology was chiefly cultivated with an *arriere pensée* as to its value for interpreting the functions in man, and hence, in claiming for this department of study the most exalted position, and the most intricate and interesting of botanical problems, we need not be distracted by any lurking *cui bono*, or feeling of having come short of ample

returns for conscientious effort, although the facts do not elucidate any point in human or animal physiology. Some of the dissatisfaction which caused G. H. Lewes to abandon the pursuit of his early dreams of a comparative psychology, and M. Foster to discontinue his early study of comparative general physiology, as both authors have assured us they did, may possibly be traceable to a lack of singleness of purpose in taking the good of the organism itself in each grade of development as the point of view in pursuing the study. But as all vital activity rests upon a common basis, it is not improbable that the key to some of the fundamental mysteries of physiological action will yet be found in a study of the well developed functions exhibited in the simpler, nerveless structure of plants, and thus a truer philosophy of life in general be attained.

In closing, a few words in regard to the future of vegetable physiology in America may not be out of place. In many ways the conditions under which botany exists in America are very different from those in other countries. In Europe the class-rooms are filled chiefly with medical students, for whom a moderate amount of botany is considered essential, and the incentive for advanced work in most instances is not strong. In this country the botanical classes are larger, with more varied interests, of which medicine forms only a small part, and the study usually stands upon the same footing as that of the other sciences. The attainment of equal recognition as a substantial element of an educational course, superseding the notion that it constituted only an efflorescence to be classed with belles-lettres and other refinements, was the beginning of a prosperous period. One of the effects of this prosperity was to make the botanist more jealous of his reputation, and with the beginning of the nineties he entered a vigorous protest against the appropriation by the zoologists of the terms "biology" and "biologist." It was fair evidence that botanists had awakened to a recognition of common interests with the rest of the world, and of the advantages of keeping well abreast with the times. Later, the systematists, finding that other departments of natural history had devised improved ways for naming natural objects, undertook to fall into line and reform the method of naming plants, which led to the first serious break in unanimity which American botanists have known. So warm has been the contention that a

few have descended to personal reflection and invective, which were never before known to mar the amicable adjustment of differences of opinion among American botanists. But this storm is likely to pass and leave the atmosphere clearer, brighter, and more invigorating; and it is to be hoped that no trace will remain of an interruption of good fellowship and general *camaraderie* which has heretofore distinguished the botanists of this country.

It is the broadened horizon for botany in general which makes the outlook for vegetable physiology so especially auspicious. This is the country of all others where its practical and educational importance is likely to be most fully recognized, and where the best equipped and most independent laboratories can most readily be established. One difficulty yet besets it, the difficulty of making known what is needed. Botany has not before required much more than a table near a window for its microscope and reagents, a case for the herbarium, and a few shelves for books, and it is difficult to make it understood that the new department needs rooms with special fittings and expensive apparatus. If there were only one well equipped laboratory in the country, it might be cited as a model, but even that advantage is yet lacking. It can be explained that the chemical side of the subject needs much of the usual chemical apparatus and supplies with many special pieces, that the physical side requires similar provision, and that many pieces of apparatus are demanded which can not be obtained in the markets owing to the newness of the subject, necessitating provision for making apparatus of both metal and glass; but the explanation rarely conveys a full appreciation of how essential and extensive this equipment is expected to be. In the fitting of the laboratory there should be rooms for the chemical work, with gas, water, sinks, and hoods, and rooms for the physical work, with shafting for transmitting power to clinostats and centrifugals, with devices for regulating moisture and temperature, and with as ample provision for light as in a greenhouse. There should also be dark rooms into which a definite amount of light may be introduced by means of arc lamps, and other special rooms for special lines of study. It is easy to see that a well stocked greenhouse is required to supply healthy plants when needed for study, but the value of a botanic garden may not be so apparent. It need only be pointed out here, however, that Charles Darwin

examined 116 species of plants belonging to seventy-six genera to prepare his brochure on climbing plants, and it might have been more complete with greater opportunities.

The man who is to preside over a department of this kind, in which research work is to be carried on, and instruction undertaken suitable to a university, can not be one of St. Thomas Aquinas's *homo unius libri*, for physiology touches upon the adjacent sciences to a far greater extent than do other departments of botany, and requires a more intimate acquaintance with a wide range of knowledge.

After careful consideration of the subject, it seems safe to predict that the next great botanical wave that sweeps over America will be a physiological one. As the green chlorophyll grain of vegetation is the great primal storage battery, absorbing and fixing the energy of the sun, and making it available for doing the work of the world, in fact supplying nearly all the power, except that from wind and water, required in commercial enterprise, whether derived finally from animal force, wood, coal, steam, or electricity, so the subject which includes the fundamental study of a matter of such universal importance will without doubt eventually attain to a place in public esteem commensurate with its importance.

Lafayette, Ind.

Botanical Society of America.

TUESDAY, AUGUST 27TH.

The first annual meeting of the Botanical Society of America was held in Springfield, Mass., August 27 and 28, 1895.

The council met in the high school building at 3:00 o'clock, all the members being present. Candidates for membership proposed by three members of the society were first considered. Five of the eight names proposed were approved by the council. Other business being prepared for the action of the society, the council adjourned, and the society was immediately called to order by the president, William Trelease.

The report of the council was read by the secretary. The names proposed for active membership were laid over for balloting until the next day, as provided in the constitution, as was also the single nomination by the council for honorary membership.

The election of officers for 1896, by ballots mailed to the secretary, was reported. There had been no election of a president, two nominees having received an equal number of votes. Other officers were elected as follows: Vice-president, William P. Wilson; treasurer, Arthur Hollick; secretary, Charles R. Barnes. The society proceeded to elect a president, choosing Charles E. Bessey.

An invitation to hold a winter meeting in connection with the Society of American Naturalists, at the University of Pennsylvania, was received. It was voted not to hold a winter meeting.

A book having already been sent to the society, it was ordered that all books and pamphlets received be deposited in the library of the Missouri Botanical Garden, and that the secretary report annually the volumes so received.

The report of the treasurer was read and referred to an auditing committee, J. C. Arthur, G. F. Atkinson and Arthur Hollick.

After announcement of the program for Wednesday, the society adjourned.

WEDNESDAY, AUGUST 28TH.

The society was called to order by the president at 10:00 A. M. The special business was action upon the nominations

for membership approved by the council. The following were elected active members: M. S. Bebb, Rockford; James R. Dudley, Palo Alto, Cal.; D. P. Penhallow, Montreal, Canada; and W. A. Setchell, New Haven, Conn.

The council having also recommended that Dr. A. W. Chapman, of Apalachicola, Florida, who by his advanced age is practically precluded from active membership, be elected an honorary member, he was unanimously so chosen.

The following papers were then read:

BRITTON, ELIZABETH G.: *Some notes on a revision of the genus* Mnium, *illustrated with specimens and photographs of types.*—The author showed how nearly the American specimens correspond with European types and descriptions.

BRITTON, N. L.: *The New York Botanical Garden.*—Mr. Britton gave an account of the movement for the establishment of the garden and the plans for its development so far as matured. A fund of $250,000 has been subscribed, obligating the city of New York to supply $500,000 for buildings. Two hundred and fifty acres have been set aside in Bronx Park for the garden, and a large-scale topographic map is now being made. It is the intention to provide laboratories and equipment for all departments of research.

Discussed by Messrs. Bailey and Robinson.

ATKINSON, GEO. F.: *A contribution to a knowledge of North American phycophilous fungi.*—Mr. Atkinson gave an account of the morphology and life history of a large number of new or imperfectly known fungi parasitic upon fresh-water algæ, for details of which the paper itself must be awaited.

At the opening of the afternoon session the following resolution was presented by L. H. Bailey:

Resolved: That the Botanical Society of America express its thanks to Dr. N. L. Britton for his account of the condition and progress of the movement for a botanical garden in the city of New York, and congratulate the people of that city on the prospect of its rapid development; and, furthermore, that the society commend the Board of Managers of the Garden and the Board of Scientific Directors for their wisdom in securing a broad foundation and an assurance of liberal management.

The resolution was adopted, and a copy was ordered to be forwarded to the proper officers of the garden.

The following papers were then read:

HOLLICK, ARTHUR: *The genus* Liriodendropsis *Newb.*—Mr. Hollick described the peculiar forms of liriodendron-like

leaves found in Amboy clays, and showed ten plates illustrating them. These are paralleled by the rudimentary leaves and early stages of perfect leaves of Liriodendron, so that the history of the fossil species is epitomized in the living.

THAXTER, ROLAND: *The Laboulbeniaceæ.* — Mr. Thaxter displayed a number of plates prepared in illustration of his monograph on this group, and used them in explaining some very important and novel points in the morphology and life history of its members.

THAXTER, ROLAND: *Notes on aquatic fungi.*—The author described the structure of Monoblepharis, and then gave an account of the morphology of a new genus with multiciliate zoospores, a description of which will be published later.

COVILLE, FREDERICK V.: *A synopsis of North American rushes.*—Mr. Coville discussed the probable phylogeny of the various groups of the genus Juncus, and pointed out the correspondence of some forms to the area of their geographical distribution.

BRITTON, ELIZABETH G.: *Some corrections in the description of Coscinodon Raui and C. Renauldi, and a comparison of the two species.*—Read by title, at the author's request.

BARNES, CHARLES R., and TRUE, RODNEY H.: *Summary of a revision of the North American species of the genus Dicranum.*—This paper was presented by Mr. Barnes. A preliminary list of species recognized was distributed, and comments made upon the more puzzling groups. A list of excluded species contains seventeen out of the eighteen "new species" recently proposed by Kindberg and Carl Müller.

At the close of the reading of papers the society proceeded to elect by ballot two members to serve as councilors for the ensuing year. B. L. Robinson, of Cambridge, and George F. Atkinson, of Ithaca, were elected.

The society then adjourned *sine die*.

Section G, A. A. A. S.

Proceedings of the Section.

The section of botany was called to order on Thursday morning by Vice-president Arthur, Mr. B. T. Galloway being secretary, and proceeded to organize by electing the following officers: councilor, B. L. Robinson; members of sectional committee, N. L. Britton, Wm. Trelease, C. R. Barnes; member of nominating committee, David F. Day; committee to nominate officers of section, F. V. Coville, F. H. Knowlton, William Trelease; press secretary, W. T. Swingle.

Mr. Galloway being compelled to leave on Friday, Mr. M. B. Waite was then elected secretary for the remainder of the meeting.

Mr. J. E. Humphrey gave a brief account of the undertaking of Dr. H. H. Field in securing the cooperation of scientific bodies and governments in the establishment of an international bureau, with headquarters at Zürich, for indexing zoological literature.

A committee on international bibliography was appointed to watch the workings of this Swiss bureau and to report to the section a plan of cooperation by which botanical literature may be included if the scheme seems to promise success. The president named Messrs. Humphrey, Coville and Underwood as this committee.

The committee on bibliography presented a report of its work during the past year.

Your committee beg leave to submit the following report:

The author index to American literature has been continued throughout the past year with the cooperation of the editors of the *Bulletin* of the Torrey Botanical Club. Various difficulties arising in the publication of this index suggest to the committee the following necessary limitations to its contents. It is therefore recommended,

1. That all bacteriological, horticultural and agricultural titles be omitted: but in any case of doubt the title is to be included.
2. That all references to exsiccatæ be excluded.
3. That all references to reviews be excluded.

The committee also report that the journal index, which it was hoped would be begun in the past year, has been delayed by the desire to cooperate with and obtain the benefit of the similar work of the Boston Public Library. The committee expect that this will be published very shortly.

We have also made arrangements for the publication of a subject index of American literature. This will be begun with January, 1896.

The committee received a grant of $25.00 from the A. A. A. S. to cover the cost of printing the rules for citation adopted by the section and the cost of distributing the same. The stereotyping, printing, and distributing of nearly 1,000 copies of these rules has left a balance in the hands of the committee of only $0.64. As a small additional expense will probably be incurred, the committee recommend that the council of the A. A. A. S. be requested to grant $5.00 additional for the expenses of the committee.

C. R. BARNES,
N. L. BRITTON,
A. B. SEYMOUR,
Committee.

The report was received and adopted.

The Committee on Geographic Botany submitted the following report:

Your committee, in considering the importance of this subject in scientific, educational, and economic aspects, have thought it best simply to point out for the use of those desirous of taking up the matter some of the more recent works on geographic botany, and certain salient points relative to its terminology and its study.

We would call attention first to Drude's Handbuch der Pflanzengeographie[1] as the most complete résumé of the subject, and to his Atlas der Pflanzenverbreitung[2] as containing the most comprehensive floral maps. For the United States, we would recommend to the student the biologic maps issued about once a year from the Division of Ornithology and Mammalogy, U. S. Department of Agriculture, in which are graphically represented the general results of a distributional study of our animals and plants.

The terminology of geographic botany has not yet attained that degree of uniformity and definiteness which proper scientific expression demands. As a beginning in this direction the following definitions of certain terms in common use are recommended for adoption:

Range: the region over which a type spontaneously grows. The word type is here used as a general term for which in particular instances variety, species, genus, or the name of any group may be substituted.

Locality: the approximate geographic position of an individual specimen. A locality may be given in general terms as "Virginia," or more definitely as "near Washington, D. C.," or still more specifically as "Analostan Island, D. C."

Station: the precise spot upon which a specimen has been collected or observed. The stations of plants, while useful in local catalogues, will seldom be employed in monographic or cartographic works, an approximate location such as that cited under the definition of locality being sufficient for these purposes.

[1] OSCAR DRUDE. Handbuch der Pflanzengeographie. pp. 528. 8°. Stuttgart 1890.

[2] OSCAR DRUDE. Atlas der Pflanzenverbreitung. pp. 8. Eight maps. f°. Gotha 1887. (Berghaus' Physikalicher Atlas, abth. 5.)

Habitat: the character of the place in which a type occurs. As examples of the use of this term, may be cited the expression "in moist woods," or "in sandy pine barrens," or "in sphagnum bogs."[3]

Your committee wish furthermore to point out one phase of work in geographic botany in which almost every botanist may render important service to the science, namely the study of the "Pflanzenformation," or as it may be styled in English, the *plant formation.* This is an assemblage of plants, living together in a community, subjected to the same environmental conditions, and working with each other to maintain their existence under these conditions. The sphagnum bog of New England, the savannah of North Carolina, the pine and oak scrub of Florida, the prairie of Iowa, the chaparral of California, the yellow pine forest of the New Mexican plateau, and many other types of vegetative growth, are examples of such formations. The extent of each formation, the identification of the plants of which it is composed, their relation to each other, and their combined relation to their environment, are matters of the deepest interest, awaiting the investigation of the systematist, the anatomist, and the physiologist.

Respectfully submitted,

FREDERICK V. COVILLE,
N. L. BRITTON,
WALTER T. SWINGLE,
Committee.

The report was briefly discussed, and adopted.

A resolution requesting a grant of $100.00 for the support of a botanical table at the Marine Biological Laboratory at Woods Hole, was presented and unanimously endorsed by the section for transmission to the council.

Abstract of papers read before Section G of the A. A. A. S.

The address of the vice-president of the Section, Dr. J. C. Arthur, on "The Development of Vegetable Physiology," was delivered on Thursday, August 29th, before a large and appreciative audience. The address is given in full in another part of this number.

Papers were read before the section on the following Friday and Monday as follows:

FRIDAY MORNING, AUGUST 30TH.

RUSSELL, H. L.: *A leaf-rot of cabbage.*—Mr. Russell described a bacterial disease attacking the petioles of cabbage leaves near the base and manifesting itself by a wilting of the leaf. It spreads into the parenchyma until it reaches the fibro-vascular bundles, in whose *alkaline* tissues the bacteria

[3] For a somewhat more detailed discussion of these definitions see Contributions from the U. S. National Herbarium **4**: 10, 11. 1893.

find good conditions for rapid development and spread. The germ apparently finds access to the tissues by longitudinal checking. The disease has not proved serious except in wet weather or on plants copiously sprinkled. It seems to be a different disease from that described by Garman.

SMITH, ERWIN F.: *The southern tomato blight.*—The more important points brought out by this paper were the non-identity of the disease with the cucumber wilt, and its identity with the potato wilt, the susceptibility of various other solanaceous plants, including the egg-plant, and the establishment of the cause of the disease. It was found that a bacillus, not yet fully studied, will set up the disease by inoculation, which after a time is followed by other organisms that produce the stinking wet-rot. The primary infection of the host takes place, as a rule, through the parts above ground.

GALLOWAY, B. T.: *Observations on the development of Uncinula spiralis.*—The development of the mycelium, conidia and perithecia, was described, bringing out many new details. The germination of the ascospores was described. It was found that material kept in thin muslin sacks staked to the ground was in good condition for study throughout the winter. The ascospores could not, however, be made to germinate until spring. A curious growth of mycelium from the resting perithecial cells was observed, which appeared to be a possible method of continuing the life of the fungus. The paper will be given in full in a later number of this journal.

TRUE, RODNEY H.: *The effect of sudden changes of turgor and of temperature on growth.*—Radicles of Vicia Faba were used for the experiments. The variations in turgor were secured with solutions of nitrate of potassium. It was ascertained that a period of retardation of growth followed a change in the concentration or in the temperature, whether the change were in an increasing or decreasing direction. The reaction is that of a shock to the irritable organism.

FRIDAY AFTERNOON, AUGUST 30TH.

WOODS, ALBERT F.: *Recording apparatus for the study of transpiration of plants.*—Describes an automatic device for continuous registration of the loss of water by transpiring plants. The apparatus is a modification of the weighing rain gauge used by the United States Weather Bureau, the principal change being to secure greater sensitiveness. This paper will appear in full in a later number of this journal.

BRITTON, N. L.: *Notes on the ninth edition of the London Catalogue of British Plants.*—The author compared the number and character of the changes in generic names in this edition with those of the "check list" of American plants, stating that only three per cent. differed, in all other cases the oldest name being accepted.

HOLFERTY, GEORGE M.: *Pressure, normal work and surplus energy in growing plants.*—Mr. Holferty first discussed the pressure exerted by roots when they meet an obstacle, showing that if the growing part is free this pressure begins at once, that the pressure increment sets in with its full amount at once, and that it reaches a normal maximum. In stems, on the contrary, pressure begins only after a latent period of half an hour, the pressure increment is an increasing quantity at first, constant for a short time, and finally a decreasing quantity for a long period. It was shown, second, that the surplus energy of plants is high when compared with normal work. The average ratios are, in the laboratory 21.8:1, in the greenhouse 5.5:1, and in the garden 4.6:1. Garden plants show a capacity of lifting weight of nearly 400^{gm} per sq. mm. of cross section.

HOLM, THEO.: *Obolaria Virginica; a morphological and anatomical study.*—The author presented a general sketch of the systematic position of the plant, based upon its morphological and anatomical characters in comparison with those of some saprophytic and parasitic plants. Its affinities are believed to lie more with Orobanchaceæ than with Gentianaceæ.

COVILLE, FREDERICK V.: *Botany of Yakutat Bay, Alaska.* This paper embodied a report upon a collection of plants made at Yakutat bay by Frederick Funston, in 1892, with a general account of the relation of plant life to environmental conditions and to native industries.

MONDAY MORNING, SEPTEMBER 2D.

The morning session was a joint session with Section F.

ARTHUR, J. C.: *The distinction between animals and plants.*—The advantages of using structural characters in distinguishing plants and animals was pointed out, and attention called to the fact that physiological characters only had heretofore been proposed. The necessity of drawing the characters from the mature vegetative individual was also urged. The following definitions were suggested: Plants are organ-

isms possessing (in their vegetative state) a cellulose investment; animals are organisms possessing (in their vegetative state) a proteid investment, either actual or potential.

MINOT, CHARLES S.: *Rejuvenation and heredity.*—The paper traced the rôle of the embryonic type of cells in plants and animals as a necessary predisposition of structure for the action of heredity. The rôle of these cells in animals and plants in reproduction and regeneration was discussed, especially to show that their functions render it impossible to accept Weismann's theory of heredity. It was pointed out that the theory in all essential particulars is Nussbaum's and not Weismann's, whose attitude towards his critics was incisively criticized.

SWINGLE, WALTER T.: *Fungus gardens in the nests of an ant near Washington, D. C.*—The nests of *Atta tardigrada* Buckl. near Washington are small subterranean cavities 6–10^{cm} in diameter, situated from 2 to 15 or 20^{cm} below the surface. Almost the whole cavity is filled with a grayish material loosely and irregularly cemented together. A large part of this substance consists of the excrements of a leaf-eating larva which the ants carry in. On these pellets the ants cultivate a fungus whose free hyphæ end in glistening spherical knobs similar to those described by Möller from the ant gardens of southern Brazil and designated by him "kohl-rabi." They are 22–52μ wide and 30–56μ long, while the supporting hyphæ are only 4–8μ in diameter. No septum divides the kohl-rabi from the stalk. The whole appearance of the fungus is strikingly similar to that described by Möller (except in being nearly twice as large) and it is not impossible that it will prove to be the same species.

BAILEY, L. H.: *Variation after birth.*—Read by title.

COVILLE, FREDERICK W.: *Poisoning by broad-leaved laurel, Kalmia latifolia.*—Read by title.

MONDAY AFTERNOON, SEPTEMBER 2D.

MACDOUGAL, D. T.: *The transmission of stimuli-effects in Mimosa pudica.*—The author showed that Haberlandt's explanation of transmission of stimuli by the "Schlauchzelle" was not tenable. Stems or petioles killed by a steam jacket for 5–10^{cm}, and those from which the phloem region (including the "Schlauchzelle") had been removed, were still able to transmit the stimulus-effect. Sudden application of a hydrostatic pressure of five to twenty atmospheres and sudden di-

minution of normal hydrostatic pressure entirely failed to produce any effect though the contact stimulus was promptly effective on the experimental plants. Excluding the hydrostatic theory of Haberlandt, at present it seems necessary to assume transmission by the tissues of the entire cross-section.

MACDOUGAL, D. T.: *The physiology of Isopyrum biternatum.*—The first recognizable carbohydrate in this plant is amylo-dextrin, starch of the ordinary type not appearing in the leaves. At certain periods a starch appears in the tubers which reacts red with iodine, a form which has been believed to be characteristic of parasitic plants.

COOK, O. F.: *Personal nomenclature in the Myxomycetes.*—Of the two systems of nomenclature, the "personal" and the "priority," only the former has been used in the Myxomycetes. This is illustrated by two recent monographs. Of 41 genera and 430 species in Massee's *Myxogastres* only 33 generic and 160 specific names appear in Lister's *Mycetozoa.* If, however, uniformity with the future is to be secured, the still more radical changes necessitated by the principle of priority should be made. Nearly all the genera established by Rostafinski must be supplanted by names disused for fifty years or longer. It also appears that the older generic names were so applied that the usual method of application of the law of priority will necessitate the shifting of generic names from one family to another, according as certain characters are looked upon as of greater or less importance. Thus there are three generic conceptions to which the name Physarum may be applied. This confusion would be avoided if we adopt the principle of considering the first species under a genus to be the generic type from which the generic name can not be separated.

CAMPBELL, DOUGLAS H.: *A new Californian liverwort.*—The author describes a liverwort, allied to the genus Sphærocarpus, collected near San Diego, which probably constitutes a new genus.

JEPSON, WILLIS L.: *The number of spore mother-cells in the sporangia of ferns.*—Read by title.

BOLLEY, H. L.: *The constancy of the bacterial flora of fore-milk.*—This paper is a report of a number of original investigations bearing upon the constancy of the species and physiological types of bacteria present in the normal fore-milk. In general it may be said that the species may be quite constant in the udder of an individual animal, but there is slight

evidence of constancy among different animals even under the same conditions.

SMITH, ERWIN F.: *The watermelon wilt and other wilt diseases due to Fusarium.*—Read by title.

MACLOSKIE, GEO.: *A root fungus of maize.*

MACLOSKIE, GEO.: *Antidromy in plants.*—The author claims to have discovered two kinds of flowering plants as to phyllotaxy, inflorescence, and, in some cases, the seeds. Of every species there appear to be dextrorse and sinistrorse individuals in about equal numbers. This difference is dependent upon the origin of the ovules being from the right or left margin of the carpel and is a primitive character which he designates by the term antidromy.

PILLSBURY, J. H.: *On the analysis of floral colors.*—Read by title.

BARNES, CHAS. R., and TRUE, RODNEY H.: *A summary of a revision of the North American species of the genus Dicranum.*—Read by title.

WEBBER, H. J.: *Experiments in pollinating and hybridizing the orange.*—Read by title.

HART, CHARLES PORTER: *History and present status of orange culture in Florida.*—Read by title.

PATTERSON, MRS. FLORA W.: *An Exoascus upon Alnus leaves.*—Read by title.

The Botanical Club of the A. A. A. S.

A meeting of the Botanical Club for organization was convened immediately following the vice-presidential address before Section G, on Thursday afternoon, August 29th. In the absence of the officers for 1895 the meeting was called to order by Geo. F. Atkinson, president for the Brooklyn meeting. David F. Day, of Buffalo, N. Y., was chosen as chairman *pro tem.* and H. L. Bolley of Fargo, N. D., as secretary. Adjourned.

FRIDAY MORNING, AUGUST 30TH.

The Club was called to order at 9:00 o'clock A. M., with President Douglas H. Campbell in the chair, and H. L. Bolley acting as secretary. About fifty persons were in attendance.

HALSTED, BYRON D.: *Field experiments with beans.*—Beans grown for the third successive crop upon a plot of ground (one-tenth acre) gave 25 per cent. of pods that were spotted with anthracnose. An adjoining plot of the same size as the first and in every way similar except that it had borne no previous crop of beans, gave only six per cent. of spotted pods.

COVILLE, F. V.: *Crimson clover hair-balls.*—These balls, measuring two or three inches in diameter, were taken from the stomach of horses, whose death they had caused. They were compact, and much resembled the hair-balls often found in stomachs of ruminants, but were entirely composed of the small barbed trichomes from the mature calyx of crimson clover (Trifolium incarnatum).

COOK, O. F.: *A peculiar habit of a Liberian species of Polyporus.*—This species produces long stipes, each successive one starting from the upper portion of the preceding one, or even from the pileus, in a proliferous manner. This continues until the plant becomes top heavy, and falls over upon the ground. Specimens were shown. The habit enables the fungus to lift the pileus well above water during the wet season.

BOLLEY, H. L.: *An apparatus for the bacteriological sampling of well waters.*—This is a modification of the apparatus already in use to secure samples of deep sea waters.

POLLARD, C. L.: *Methods of work on the National Her-*

barium.—The transfer of the herbarium from the rooms of the Department of Agriculture to those of the Smithsonian Institution was spoken of, and the method of mounting and caring for the specimens described.

In the discussion it was developed that the resolutions of the Club and the requests of the botanists of the country had had material effect in bring about the transfer of the collections to a fireproof building.

BRITTON, ELIZABETH G.: *Some notes on Dicranella heteromalla and allied species.*—A drawing of a small mountain form with curved pedicels was shown, and it was pointed out that D. Fitzgeraldi is referable to D. heteromalla orthocarpa.

The report of the committee of the Club to prepare a check list of plants of northeastern North America was called up and somewhat discussed, but owing to the lateness of the hour was interrupted by adjournment.

FRIDAY AFTERNOON, AUGUST 30TH.

The Club met immediately after adjournment of the afternoon session of section G. The unfinished business was a pending motion to accept the report of the committee on the check list. It was agreed that a discussion of the principles upon which that list is based was in order. After a prolonged discussion of various points, by Messrs. Robinson, Coville, Britton, Cook, Fernow, Barnes, Galloway, Bailey, Greene, and others, a resolution was offered by Mr. Britton increasing the committee on nomenclature by the addition of C. S. Sargent and B. L. Robinson, and directing the committee to report to the Club desirable modifications and additions to the present code. Mr. Robinson having repeatedly declined to serve as a member of the committee, Mr. L. H. Bailey was appointed in his stead. The Club then adjourned.

MONDAY MORNING, SEPTEMBER 2D.

The Club was called to order at 9:20 o'clock, A. M., with David F. Day, president *pro tem.* in the chair, and H. L. Bolley acting as secretary. About thirty persons were present.

Upon motion a committee to nominate officers for the next meeting was appointed, consisting of Messrs. Britton, Seaman and Deane. The report of the treasurer was received, which showed a balance in the treasury of $6.57.

Papers were then read as follows:

BRITTON, ELIZABETH G.: *Corrections in descriptions of Coscinodon.*—A drawing of C. Raui was exhibited, some mistakes in the description of the leaf, and peristome corrected, and a comparison with allied species made.

The following papers, in the absence of the authors, were read by title only:

TRELEASE, WILLIAM: *Notes upon pignut hickories.*

HALSTED, B. D.: *Experiments with lime as a preventive of club-root.*

SMITH, ERWIN F.: *Notes on the alkaline reaction of the vascular juices of plants.*

ATKINSON, GEO. F.: *Continuation of experiments upon the relation between the fertile and the sterile leaves of Onoclea.*

ROLFS, P. H.: *A hybrid between an egg plant and a tomato plant.*

WOODS, A. F: *A method of using formalin gelatin as a mounting medium.*

This completed the printed program, and additional papers were called for.

ARTHUR, J. C.: *A new clinostat.*—An apparatus was shown and described, which would slowly revolve four flower pots at the same time, with a uniform speed, two of the pots having a position at right angles to the other two. By the movement of a lever it could be converted into an intermittent clinostat, the pots turning half around each half hour, or hour, as desired.

SEYMOUR, A. B.: *Description of the collection made by Miss Gilbreth to illustrate seed distribution.*—This paper was read by Mrs. Flora W. Patterson, the author being absent. It described quite fully this admirable collection, and request was made for donations or exchanges to extend it and make it more complete. A discussion followed upon various modes of seed dispersion.

David F. Day called attention to the curious intermittent method of twining observed in Dioscorea, and also to a circumnutation of the pedicels of Anemone Virginiana.

The report of the nominating committee was now received and adopted, and the following officers of the Club for 1896 were thereby elected: President, F. V. Coville, Department of Agriculture, Washington, D. C.; Vice-President, Conway, Macmillan, University of Minnesota, Minneapolis, Minn.: Secretary and Treasurer, John F. Cowell, Buffalo, N. Y. Adjourned.

Noteworthy anatomical and physiological researches.

The rhizoids of filamentous algæ.[1]

While a few theories have been advanced to explain the occasional formation of rhizoids on those forms of filamentous Chlorophyceæ on which rhizoids do not normally occur, the author is the first to attempt to demonstrate their cause by experiment.

The observations were made from artificial cultures of two kinds, the so-called "contact cultures" and suspended cultures. In the former, the cultures were made either on a slide, between a slide and a cover glass, or in a hanging drop. In the suspended cultures a tuft of algæ is tied about the center with a slender linen thread, all rhizoids having first been removed, and suspended in a culture fluid. By this means liability of one filament coming in contact with another is in most cases removed. Various substances were used in making the media, and these in different degrees of concentration. The author gives in detail cultures made in solutions of agar-agar, gum, albumen, urea, cane sugar, milk sugar, erythrite, asparagine, glucose, dulcite, mannite and glycerine, and mentions cultures made in solutions of citric acid, berberine, potassium tartrate, sodium chloride, potassium nitrate, potassium sulphate, magnesium sulphate, sodium nitrate, aluminum sulphate, potassium alum, and in stained solutions of indigo carmine and nigrosin. None of the latter, however, were very successful, as the staining prevented the free action of light, and in the others the algæ died, even in very weak solutions.

The first results were obtained in contact and water suspension cultures; these were followed by the various other suspension cultures. As a result of these experiments he concludes that rhizoid formations of Spirogyra depend upon certain external influences from contact with a firm body. Notwithstanding the great number of cultures made, he confesses that his investigations are insufficient to fully explain the nature of these external influences.

At the two extremes of the series are the contact cultures

[1] Borge, O. *Ueber die Rhizoidenbildung bei einigen fadenformigen Chlorophyceen.* Upsala, 1894.

and the water suspension cultures. In the one, rhizoid-like outgrowths were obtained in all cultures (thirty-one) of *Spirogyra fluviatilis* Hilse, *S. inflata* (Vauch.) Rab., *S. orthospira* Naeg., and in four undetermined species. In the other, in no case did the formation of rhizoids result. In some cases water suspension cultures which showed no result, when transferred to contact cultures developed rhizoids in from two to four days.

That other conditions influence this development is shown by the growth in different media, the required density differing with the different media, as well as with the species; *e. g.*, in agar-agar, the lowest limit favorable to the formation of rhizoids, was a .05 per cent. solution, while for a gum solution it lay between .5 and 25 per cent.

The development of rhizoids by contact culture was also attempted under the influence of darkness, but the conditions were unfavorable for the development of the filaments themselves although in some cases rudimentary rhizoids occurred during the first few days.

One of the most interesting results derived from the research was in connection with *S. varians* (Hass.); in this species no rhizoids were developed, but, contrary to the statements of Vaucher, Pringsheim and De Bary, the author concludes after observing the germination of the zygote in three different cultures that the so-called "rhizoid cell" of the germinating tube does divide to form the cellular increase of the filament.

Cultures of Zygnema showed no rhizoid growth. In the cultures of Mougeotia the rhizoids were also conditioned by external mechanical influences since none were formed except in contact cultures.

Similar cultures were made of Vaucheria and of those forms in which the formation of rhizoids is more or less normal; *i. e.*, Cladophora, Draparnaldia, Œdogonium and Ulothrix. While no rhizoids were obtained on mature threads of *Vaucheria clavata* (Vauch.) DC., their presence was observed on germinating filaments. On *V. sessilis* (Vauch.) DC. none were produced under any circumstances. Both old and young threads of Cladophora, Draparnaldia, and Ulothrix formed rhizoids under all conditions. On early germinating threads of Œdogonium rhizoids were formed in all cases but the property seems to have become lost in older threads.

In summing up, the author advances the theory that the

variations in the different species, at least in many cases, bear a close relation to the conditions of growth; so that those species which are generally found in rapidly flowing water formed rhizoids under all conditions and the rhizoid formation may be considered as a specific character. An entirely opposite condition exists in those species of Spirogyra which in no case formed organs of attachment (S. varians, Weberi and others not specifically named). *Spirogyra fluviatilis* and *Vaucheria clavata* may be regarded as a mean between the two extremes; these formed rhizoids but in contact cultures only, and he suggests that these might gradually have acquired this ability from species in which the necessity for rhizoids was originally wanting. This view confirms that of Klebs,[2] who suggests that *V. clavata* might be regarded as an offshoot of *V. sessilis* which has been removed from its accustomed habitat into rapidly flowing water.

The experiments were conducted in the laboratory of Prof. Klebs of Basel and the results are published in pamphlet form. Two plates illustrating the various results are appended to the text.

The work gives evidence of careful thorough investigation and it will be read with interest by all who have made a study of these forms of algæ.—BERTHA STONEMAN.

Investigations on bacteria.[3]

Under the above general title, Alfred Fischer has recently published a lengthy paper which, in part, deals with a subject that has received but scant attention from bacteriologists. The paper is divided into four parts, which treat respectively of plasmolysis of bacteria, physiology of motile organs, morphology of cilia, and systematic bacteriology.

In the first three parts, the author draws attention to many points of interest that he has observed in his studies, and discusses the relation of the same to the different theories that have been advanced from time to time.

I. He brings further proofs to substantiate his earlier claim[4] that the bacterial cell is subject to plasmolysis like the higher plant forms. Plasmolysis frequently occurs in the preparation of ordinary cover glass mounts where the evaporating

[2] Zur Physiologie der Fortpflanzung von Vaucheria sessilis. Verhandl. d. naturforsch. Ges. in Basel **10:** —. 1892.

[3] Untersuchungen über Bakterien, Jahr. f. Wiss. Bot. **27:** 1–163. 1895.

[4] Ber. d. konigl. sächs. Ges. d. Wiss. —: 52. 1891.

drop containing the bacteria undergoes a concentration of saline material sufficient to induce plasmolytic action. The lacunæ and uncolored areas so often noted in many different species of bacteria, when stained indicate where the protoplasm has shrunken from the limiting membrane under the action of the salt solutions. In certain instances plasmolyzed preparations recovered their turgor by the permeation of the salt solution into the bacterial cell. The protoplasm of the same species, however, is not permeable to different salts in an equal degree.

The importance of these observations on plasmolysis are considerable, as they have a direct bearing on the theory of the nature of the bacterial cell.

According to Bütschli[5], that part of the cell that absorbs the basic aniline dyes with ease is nuclear in its character. This large nucleus is surrounded by a membrane that does not easily stain. The cytoplasm of the cell is either entirely absent or is reduced to a mere film between the two layers.

In his preparations, Fischer finds an evident contraction of the interior cell substance when submitted to the influence of different salt solutions similar to those observed with higher plant forms when plasmolyzed. According to him, no nucleus has yet been determined. His results homologize the bacterial cell with that of higher plants as far as the cell elements are represented, and also with reference to plasmolytic action.

II. The view has been advanced that the cilia of swarm spores of different plants, and also bacteria, are protoplasmic processes that are extruded from the main part of the cell through minute openings in the limiting membrane, and that these filiform appendages are capable of being withdrawn entirely within the cell proper. If this were so, plasmolyzed bacterial cells would hardly be expected to show any appreciable degree of motility, yet, a number of different motile forms plasmolyzed in weak solutions (2.5 per cent. KNO_3, 1.25 per cent. NaCl), showed no cessation of movement. If strong solutions were used, motion ceased immediately. This was not, however, on account of the retraction of the cilia, but a rigor caused by the concentration of the solution.

The addition of disinfectants (carbolic acid, 0.1 per cent.) in proportions insufficient to cause a cessation in development, likewise sufficed to produce a similar state of rigor.

[5] Bau der Bakterien. 1890.

III. In taking up the question of the morphology of the cilia, details are given of a method of staining that is a simplification of the Löffler method.

After the general discussion of cilia and their separation into two classes, polar and diffuse, observations are noted on the changes that take place in the form and character of the cilia under different phases of development.

In several instances, sporulation took place without a cessation in motility, and in some cases degenerate phases of development, such as involution forms, were still characterized by movement.

The cilia are to a certain extent independent of the main protoplast of the cell. Ability of motion and contractility reside in the cilium itself, likewise a certain irritability which sometimes brings about an increase of motion, sometimes a rigor. At the same time cilia are not completely independent of the protoplast as they lose their motility if not in contact with the main body of the cell. Under the influence of plasmolytic action, they remain in close connection with a small fragment of the protoplasm within the cell.

IV. The final part of the paper takes up the vexed question of the systematic part of the science. In this, Fischer favors a system of classification founded on a morphological basis rather than an attempt to use physiological data for differential characteristics.

His proposed scheme is based (1) on the presence and arrangement of the cilia, (2) the formation of spores, and (3) the morphology of the spore-bearing cell.

A marked feature of the system is the use of the same root to designate the genera having the same form of cell although differentiated into various subfamilies on account of other characteristics. Thus, the genera, Bacillus, Bactrinium, Bactrillum, and Bactridium are all cylindrical spore-bearing rods characterized by a difference in arrangement of motile organs. The different genera in each subfamily are likewise characterized by the use of a uniform suffix, as for instance, the subfamily Bactriniei, has its genera terminating in *inium* (Clostrinium, etc.), while the genera of the coordinate divisions Bactrillei and Bactridiei end respectively in *illum* (Clostrillum) and *idium* (Clostridium).

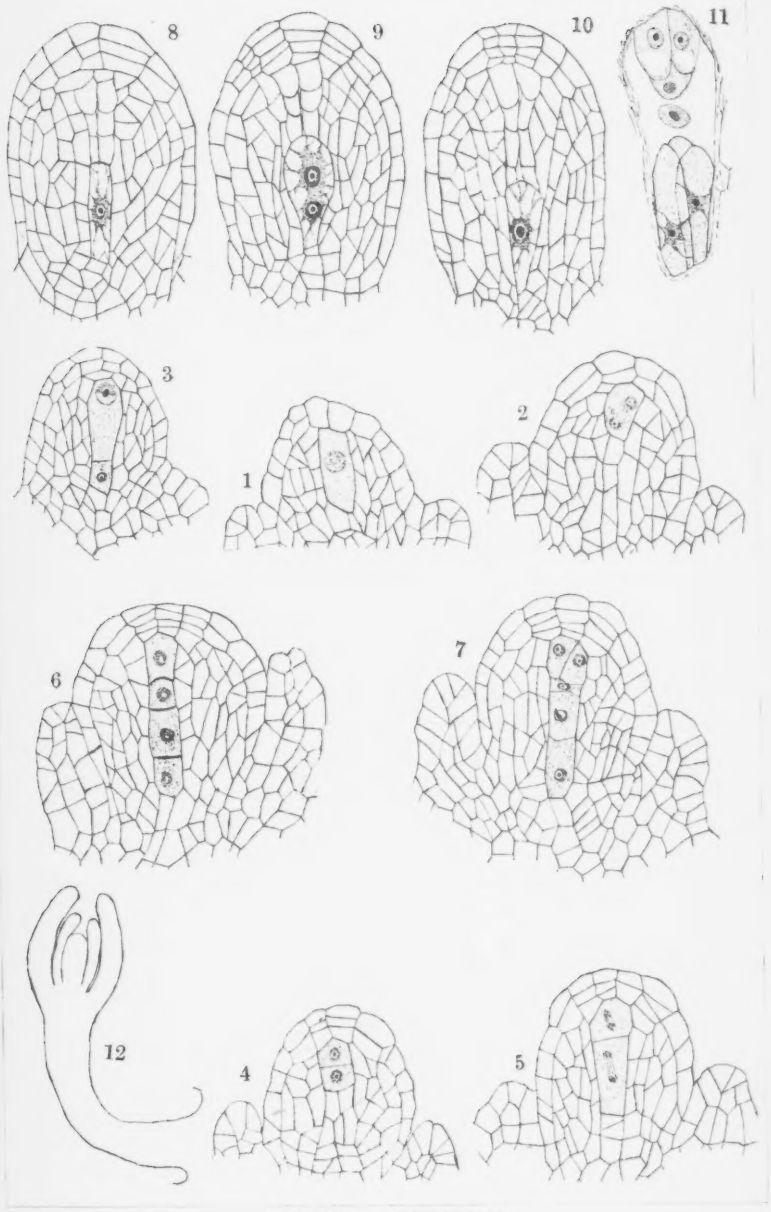
This arrangement necessitates a large number of genera and by this method the author hopes to relieve the overbur-

dened condition that is found in the present genus Bacillus. The logical nature of this scheme is praiseworthy but the present necessities of our classification hardly warrant the formation of a number of genera for which there are no known representatives.

The fact that the author himself is forced to note under many of the genera that "bisjetzt ist kein Vertreter dieser Gattung bekannt" and also that under the genus Bactridium, "hierher scheinen eine grössere Zahl von Stäbchenbakterien zu gehören" is evidence of the inherent weakness of the system.

The difficulty of founding any system of classification upon a characteristic so difficult to determine with accuracy as the presence and arrangement of such delicate organs as the cilia of bacteria is apparent. Even with much simplified methods of staining, the study of these motile organs is not an easy task and when used as a basis for classification would cause more confusion than now exists. The author ignores completely all reference to a similar system proposed by Messea[6] in 1891 which failed of acceptance on account of the many new difficulties that it introduced. Desirable as a system would be that is based on morphological data entirely, none has as yet been presented that is as convenient and practical as those that employ physiological characteristics in addition to the morphological variations of the cell.—H. L. RUSSELL.

[6]Contribuzione allo studio delle ciglia dei batterii e proposta di una classificazione. Rev. d'Igiene **1**: —. 1891. [No. 14.]



ANDREWS on JEFFERSONIA

THE
JOHN CRERAR

BRIEFER ARTICLES.

Development of the embryo-sac of Jeffersonia diphylla. (WITH PLATE XXVIII.)—*Jeffersonia diphylla* Pers. is a very favorable plant in which to study certain phases of embryology. This is due partly to its large cells and nuclei, and partly to the fact that its embryonic tissues are very readily stained and sectioned. Several stains were used, such as haematoxylin, fuchsin, and alum cochineal, with fair success, but for staining *in toto* alum cochineal proved most satisfactory. The sections were counter-stained on the slide with Bismarck-brown.

The mother-cell of the embryo-sac arises as an hypodermal cell at the apex of the nucellus. It contains but one nucleus and always stands with its long axis parallel to that of the nucellus (fig. 1). No tapetal cell is formed in this plant. In an ovule that has advanced somewhat in development we find that this mother-cell is preparing to divide into two similar cells by a transverse wall (figs. 2 and 4). This is indicated by the dividing nucleus (fig. 2).

In the next step toward maturity, it is noticed that the two cells just formed repeat in every detail (fig. 5) the process just described; so that there are now four cells resulting from two successive divisions of the mother-cell (fig. 6). Occasionally the uppermost of these four cells divides into two by an almost vertical wall (fig. 7). The transverse walls separating these four cells are somewhat swollen, and more distinct than the others (fig. 6). By repeated periclinal divisions of the epidermis of the nucellus, the row of four daughter cells is soon covered at its summit by four or more layers of cells (fig. 6). The number of these layers seems to increase quite uniformly with the age of the nucellus, though some exceptions were noted (figs 4, 5, 6).

In figure three (3) are shown two cells, the upper of which is much the larger. From my own observations it does not seem probable that the lower cell has arisen by division from the upper one, but that it is merely a cell of the axial row which did not divide but merely increased in size.

Of these four cells, which by successive divisions have arisen from the mother-cell, the lower one undergoes further development and becomes the embryo-sac. This cell increases in size at the expense of the three cells above it, together with the adjacent cells of the nucellus (fig. 10). The upper three cells are first absorbed and their cavities become almost obliterated by the surrounding turgid cells of the

nucellus (figs. 8, 9, 10). Their disorganized remains now occupy a narrow cavity above the enlarging embryo-sac.

The further development of the embryo-sac is perfectly normal. The primary nucleus soon divides (fig. 9), one of the resulting nuclei passing to the upper and the other to the lower end of the sac. Further details need not be given here.

In this plant the mature embryo-sac does not reach the integuments, but is covered at its summit by a cap of about six cells in thickness, formed from the tissue of the nucellus. The cavity of the embryo-sac when nearly matured is very large, and is often readily seen by the unaided eye in section. Both the antipodal cells and the egg-apparatus are also very large. Of the former especially is this true, for they occupy about half of the entire length of the sac containing them (fig. 11). Shortly before they are absorbed, however, the embryo-sac has enlarged greatly, so that this relation is not maintained. The nuclei of the antipodal cells are also very conspicuous, while even the protoplasmic bridges or threads are plainly visible (fig. 11).

In the lower end of the synergidæ and below the nucleus of each there is a vacuole (fig. 11). One is also to be seen in the upper end of the oosphere by focusing, but as this cell lies below and is partially covered by the synergidæ, it is obscured from view.

The ovules of this plant are anatropous, but in one instance observed, an ovule was borne on a very long stalk which arose at right angles to the surface of the placenta, then by a long curve extended upward in the cavity of the ovary to a height of the second ovule inserted above it (fig. 12).

The foregoing may be summarized as follows:

1. The embryo-sac arises as an hypodermal cell at the apex of the nucellus.
2. This cell divides first into two cells. Each of these cells again divides, thus forming four. The lower of these alone undergoes further development and becomes the embryo-sac.
3. The upper daughter-cell is occasionally divided into two by an almost vertical wall.
4. The antipodal cells are unusually large.

This work was carried on under the direction of Prof. D. M. Mottier, who has very kindly supplied me with an abundance of properly preserved material.—Frank M. Andrews, *Bloomington, Ind.*

Explanation of Plate XXVIII.—Fig. 1. Longitudinal section of very young ovule showing hypodermal cell at apex of nucellus.—Fig. 2. Same, undergoing division.—Fig. 3. Division completed.—Fig. 5. Both cells again undergoing nuclear division.—Fig. 6. This is completed and walls formed.—Fig. 7. The upper of the four cells has divided into two by an almost vertical wall.—Figs.

8, 9 and 10. The first three steps in the development of the embryo-sac from the lower cell of the four shown in Fig. 7. Integuments are not shown.—Fig. 11. Outline only of embryo-sac with egg apparatus and very large antipodal cells.—Fig. 12. Ovule borne on a long stalk. × 150. Figs. 1 – 11 × 420.

Laphamia ciliata, sp. nov.—Perennial, fruticose, 15–30^{cm} high, with slender terete spreading branches, cinereous-pubescent throughout: leaves alternate or the lower sometimes opposite, deltoid or ovate, more or less punctate especially on the upper less pubescent green surface, somewhat decurrent on the petioles, these about half as long as the blades; lower leaves 10–15^{mm} long and about as broad, crenate or irregularly dentate: upper leaves decreasing in size, narrower in proportion to their length and more deeply toothed: heads on slightly clavate pedicels 5–15^{mm} long terminating the short upper branches, light-yellow, about 40-flowered, 5–7^{mm} in diameter; involucral scales usually 12, equal, obscurely biseriate, oblanceolate, about 2^{mm} wide near the apex, persistent, spreading or slightly reflexed at maturity: rays nearly white, crenately 3-toothed, 7-nerved, pistillate, about 3^{mm} long and 2^{mm} wide above the throat; disk flowers perfect, yellow, 4^{mm} long including immature akene 2^{mm} long; style branches exserted, recurved, 1^{mm} long, minutely pubescent; akenes flattened, oblong, slightly curved, 2^{mm} long, 0.5^{mm} wide, black, with white callous ciliate margins; pappus a callous crown with 2 subequal hispidulous bristles 2^{mm} long, from opposite margins.—Type specimen in National Herbarium collected by D. T. MacDougal, on rocks along Pine creek, near Pine, Arizona, August 21, 1891, no. 676. Cotype in National Herbarium, collected by J. W. Toumey, on Tucson mountains, near Tucson, Arizona, May 15, 1892, no. 629.

This species has the habit of *Laphamia rupestris* and agrees in all respects except the akene with the generic characters of *Laphamia*. The akene with its cartilaginous ciliate margin agrees with the characters of *Perityle*. The small many-flowered heads and the ciliate-margined akenes with a pappus of two slender bristles distinguish it from any similar species of Laphamia, while the fruticose much branched habit and nearly entire leaves distinguish it from any of the known species of *Perityle*.—Lyster H. Dewey, *Washington, D. C.*

EDITORIAL.

THE NOMENCLATURE QUESTION was opened in the recent meeting of the Botanical Club by the submission, on the part of the committee, of its report in the form of the printed "List of Pteridophyta, etc." Two diverse positions had developed previous to the meeting. Some advocates of reform declared that the list, being simply the expression of principles already adopted, was already the official utterance of the club regarding the plants included; while others held that the list was prepared for the purpose of furnishing a basis for discussion of the principles exemplified in it. The latter has been the position assumed by the GAZETTE.

The action of the club, in effect endorsing this position by receiving the report and continuing the committee with two additional members, appears to us therefore eminently wise. The duty of the committee during the coming year seems plain. Having in view (1) the objections to the Rochester and Madison principles which have been and may be made in this country and Europe, (2) the suggestions which have been made in other countries as to desirable amendments to the Paris code, and (3) the difficulties which have developed in specific application of existing principles, it is to be hoped that the committee will frame a complete code, based upon the DeCandollean, which may be perfected as far as possible and presented to the first international congress convened for that purpose, as the concrete expression of the views of American botanists.

THERE IS EVIDENTLY a good deal of misunderstanding regarding the status of the Rochester and Madison rules. They have been spoken of frequently as "the American code" and have been regarded as the settled and formal expression of the Botanical Club. It has also been assumed that they are to be forced upon the world by a handful of obscure botanists without reference to the action of other countries or of an international congress. Many of the signers of the "Harvard protest" and some of the radical reformers have held one or the other of these misconceptions. But the "American code" is yet to be formulated; its authority, which can rest only in the acquiescence of American botanists, is yet to be obtained; and its weight in the international congress to which it must be submitted is yet to be determined. The Rochester and Madison rules in the main commend themselves to the sober judgment, and we look hopefully for the complete code which the committee should prepare for our consideration.

THE MOST CONSERVATIVE botanists acknowledge that something of this sort ought to be done—nay, *must* be done in view of existing conditions. The real difference of opinion seems to be as to the advisability of using such a code as a guide in publication before it has been sanctioned by an international congress, and this question ought to be kept distinct from the approval of the reform principles themselves. In view of the history of nomenclatorial reforms, we feel justified in advocating such use; but there may well be difference of opinion here. Let it be so; but let us, in spite of this difference, unite in perfecting an American code in readiness for the congress, which must come sooner or later. Send to the committee all the objections and suggestions possible. Their all too thankless task has not been light, and conservative and radical alike should be grateful to them for the gratuitous service they have already rendered, and will, we trust, yet render.

***

THE FIRST MEETING of the Botanical Society of America must be looked upon as very successful. The membership is still small, and from the close scrutiny to which candidates are subjected will only increase slowly. Considering the limited membership, the attendance at Springfield (70 per cent.) was large. The following were present: Arthur, Atkinson, Bailey, Barnes, Britton (N. L.), Britton (Mrs. N. L.), Coville, Greene, Halsted, Hollick, Robinson, Sargent, Scribner, Thaxter and Trelease. The papers were of value and interest.

AN EXODUS from "the land of 'poco tiempo'" should be organized by our conservative friends. "The future," for which the law of homonyms is declared to be good, is like the small boy's promised "to-morrow"—difficult to define.

THE NOMENCLATURE QUESTION has received altogether admirable treatment in an article by Prof. Lester F. Ward in the July number of the *Bulletin* of the Torrey Botanical Club. No personal detraction diminishes its force.

ABSOLUTE UNANIMITY of opinion and action is demanded among the reformers. We fail to find such unanimity even among the advocates of a *laissez faire* policy, where it is much more to be expected.

OPEN LETTERS.

The nomenclature question: theoretical objections to a stable nomenclature.

In the August issue of the GAZETTE Dr. B. L. Robinson by a skillful argument endeavors to demonstrate a certain alleged weakness in the Botanical Club principles of nomenclature. In this case, however, as in all matters concerned with nomenclature discussions, we should, as Dr. Robinson has more than once insisted, deal with actual illustrations, not with theoretical objections. In the matter of Otto Kuntze's non-application of the principle known as the rejection of homonyms to his genus Aster, I stand corrected. Such correction, however, invalidates this particular case of the support it would otherwise offer to Dr. Robinson's objection to the principle in question, for he still occupies his original position of citing only suppositious cases. The validity of this objection, it must be pointed out again, rests not on what *might* happen but on what *has happened*. The Botanical Club list enumerates about four thousand species, to all of which the principle has been applied, and if it contains any cases approaching in absurdity those Dr. Robinson has held up as bug-bears, I do not know of them.

I accept with pleasure Dr. Robinson's explanation of his reference to the representative character of the Madison assemblage of botanists, and in my turn I must explain that my interpretation of his remarks on that topic was due to the fact that the alternative explanation, the one he now presents, seemed impossible of maintenance. The records will certainly show that the principles themselves were formally adopted by the Botanical Club. The committee was then instructed to prepare a list in accordance with these principles, and this they have done. As for making the list itself "official" by some kind of formal vote to that effect, I am inclined to think that I for one should oppose such action. Surely the list must be supported primarily, and it may perhaps be said exclusively, by its conformity to principle. Any errors it contains cannot be made correct by a mere vote, nor, if an error is demonstrated, can one be expected to go on repeating it.

Probably the greatest objections that can be urged against the Association principles of nomenclature are those which may be brought forward relative to this very rejection of homonyms. These objections Dr. Robinson alone, among all the opponents of a rational nomenclature, seems to have grasped. I may perhaps be able to render some assistance in the discussion and elucidation of the subject.

The vital reason for the rejection of homonyms may be expressed as *the rejection of revertible names*. If a *Juncus megacephalus* of Curtis, 1834, has been for insufficient reasons relegated to synonymy and it is now an open question whether the species may not be a valid one, surely no one, with a view to stability, can oppose the rejection of a *Juncus megacephalus* of Wood, 1865. The latter name being replaced

by another, it matters not from a nomenclature standpoint whether the *J. megacephalus* of 1834 be treated as distinct or as identical with some older species. To go a step further: a variety *paniculatus* of Engelmann, 1868, must be erected into a species. The name *Juncus paniculatus* is already twice preoccupied by European plants, both now referred to other species. Who is to decide whether either of these is likely to prove valid? Are not different decisions likely to be rendered by equally reputable botanists, whose conceptions of these species may differ? The committee has answered these questions, as well as all the other questions which logically follow them, by saying, "We will reject not merely those homonyms which we know to be revertible and those which we suppose may perhaps be revertible, but we will reject all homonyms and thus make revertibility impossible." Considered from the standpoint of stability the wisdom of this decision is, it seems to me, incontrovertible. I am well aware, however, that the considerations I have just mentioned will have no weight with Dr. Robinson if he really believes, as I can hardly bring myself to think he does, that a stable nomenclature is impossible. If having reviewed the whole Botanical Club principles adversely and with critical care, he finds in them only one possible chance of instability, and if from a list of four thousand species he does not cite a single case in point, one surely cannot ask for a more favorable commentary on the stability-producing capacity of the system.—FREDERICK V. COVILLE, *Washington, D. C.*

Decapitalization.

Mr. Sheldon's open letter in the June number of the GAZETTE affords me another opportunity to speak against the tendency of many botanists to follow a bad example set by our friends the zoologists: that of decapitalization of specific names derived from proper names.

If Mr. Sheldon writes his specific name *bajaensis* then Prof. Greene is right in his claim that it is a trivial and meaningless combination of Spanish and Latin. *Bajaensis* on the contrary leads us to the knowledge that the species came from Baja, a town in Mexico. His coreference to *nevadensis* as a good Latin specific name is another instance. *Nevadensis* claims the species to have been found in the state of Nevada, while *nevadensis* leads us to the belief that the species is *of the whiteness of snow*, and would be at the same time again a Latino-Spanish "jumble."—C. F. MILLSPAUGH, *Field Columbian Museum, Chicago.*

NOTES AND NEWS.

In *Gardener's Chronicle* of August 24th, *Lilium Parryi* Watson is described and figured.

Rodney H. True, Ph. D. (Leipzig), has been appointed instructor in pharmacognostical botany at the University of Wisconsin.

Dr. W. A. Setchell, instructor in botany in Yale University, has been appointed to a professorship in botany in the University of California.

A Spanish translation of J. W. Harshberger's paper on "Maize" (Publ. of Univ. Penn.) has been made by Dr. Nicolas Leon of Guadalupe Hidalgo, Mexico.

In his revision of the African species of *Eriosema* (a genus near *Rhynchosia*) now completed in *Jour. Bot.*, Mr. E. G. Baker enumerates forty-nine species, nineteen of which are new.

Dr. J. E. Humphrey has been appointed lecturer in botany at Johns Hopkins University. This is a step in the right direction. We trust the department will be developed as rapidly as funds will permit.

Gautier and Etard have separately announced that the composition of chlorophyll varies. Thus far the differences pointed out are those of widely separated groups of plants, such as grass, spinach, and fern.

Ginn & Co. announce this fall the "Elements of Plant Anatomy," by Emily L. Gregory, of Barnard College, and as in preparation "A High School Botany," by J. Y. Bergen, Jr., of the English high school, Boston.

The current number (Bull. 9, Part 6, Aug. 26) of *Minnesota Botanical Studies* is entirely devoted to "A contribution to the bibliography of American Algæ," by Josephine E. Tilden. The titles, 1544 in number, are arranged by authors.

The attention of botanists is called to the fact that the American Association table at Woods Hole is equally open to them as to zoologists. Up to the present time no botanist has occupied it. Inquiries may be addressed to the Director, Dr. C. O. Whitman.

The important collections of the late Professor D. C. Eaton have been offered as a gift to Yale University if the institution will purchase the library. We are not informed as to how the offer has been received by the university. It is to be hoped that the library and collections will not be scattered.

The Vienna Botanical Exchange Society has determined upon extending its exchanges to extra-European plants. American botanists who desire to obtain European plants will find it to their advantage

to write for rules and terms of exchange to J. Dörfler, Wien, Austria, III. Barichgasse 36.

MR. O. F. COOK will shortly return to Liberia to continue his studies of tropical fungi and other plants.

MR. D. T. MACDOUGAL, of the University of Minnesota, has returned from his trip abroad. Most of his time in Europe was spent in the laboratory of Professor Pfeffer at Leipzig in the study of the transmission of stimuli.

THE LIBRARY of the American Association for the Advancement of Science is to be deposited with the University of Cincinnati. It is especially rich in proceedings of foreign societies. Books may be drawn by members of the Association and forwarded as they may direct.

MR. E. P. BICKNELL (*Bull. Torr.* 22: 351) has described two new species of *Sanicula* from the eastern United States, dissociating them from the well known *S. Canadensis* and *S. Marylandica*, and naming them *S. gregaria* and *S. trifoliata*. In the same number Mr. John K. Small continues his studies in our southeastern flora, describing as new a *Sieglingia*, a *Rumex*, and a *Acer*.

STRASBURGER'S statement of the period when the reduction of chromosomes observed in the gametes takes place is called in question by Haecker, as not consistent with observations on the same process by zoologists. He thinks there may be such a thing as "pseudo-reductions." The homologizing of this process in plants and animals is extremely important if possible.

MR. J. G. LEMMON has issued a third (pocket) edition of his very handy book on "West-American cone-bearers." The plea for good English names is strongly put, a thing which will be best established by just such a book as this, for it should find a place in the pocket of every one coming in contact with our western conifers who is at all interested in distinguishing them. Mr. Lemmon's address is Oakland, California.

THE CITY of Norwalk, Conn., is the home of the "Norwalk Tree Inoculation Co.," which, for a consideration, proposes to keep trees free from injurious insects. To this end (the consideration!) the trees are bored with from two to four 1-inch auger-holes, in which a secret compound (which consists of flowers of sulphur disguised with carbon), is placed, and the hole closed with a wood plug. Many persons in the Connecticut valley have been victimized. We understand that the state right for New Jersey was sold for $6,000. Mr. L. O. Howard, chief of the Division of Entomology, has exposed the fraud.

MASSEE'S "British Fungus Flora" was promised to us in three volumes. In the third a supplementary volume was announced, in which the Pyrenomycetes and Tuberaceæ were to appear. This fourth volume is now at hand, but does not contain these groups, so that the inference is that there will be a fifth volume. The genus *Schweinitzia*

of the fourth volume cannot be accepted, as we have a genus of flowering plants by that name in this country. It was given by Elliott and may be found among the *Ericaceæ* of Gray's Manual. It is also duly recorded by Bentham & Hooker in *Genera Plantarum*, **2**: 606.

In the *Bull. de l'Herb. Boiss.* of August, G. Lindau describes twenty-two new species of American Acanthaceæ, ten of which are from Bolivia, and the rest from Brazil, Venezuela, Central America and Mexico. Ten of the species belong to *Ruellia* and six to *Aphelandra*. In the same number, studies in the African flora are continued by Schinz, assisted by numerous specialists. Hackel describes twenty-four new grasses; Schinz proposes a new zygophyllaceous genus (*Kelleronia*); Klatt describes twenty-seven new Compositæ, of which *Pentatrichia* is a new genus; and altogether eighty-nine new forms are presented.

Radais, from his study of the development and structure of the female flower of Conifers, claims that only in *Taxoideæ* does the seed remain naked until maturity, ample protection being afforded by the scales of the cone. We do not see that this has anything to do with the gymnospermy of these plants, as the ovule still remains naked so far as its own sporophyll is concerned. The homologizing of gymnosperm ovule with an angiosperm "pistil" is certainly questionable, for there is no reason why the somewhat loose term "flower" need be used in a different sense in the two groups. That Coniferæ are archegoniates whose method of fertilization has been modified by removal from water is certainly a reasonable conclusion.

The first botanical publication from the Field Columbian Museum (Chicago), is entitled "Contribution to the Flora of Yucatan," by Dr. C. F. Millspaugh, Curator, Department of Botany. Last January an expedition from the Museum visited Yucatan and certain neighboring islands, accompanied by Dr. Millspaugh. A small collection of plants was made which forms the basis of the present contribution. The list given includes not only the plants collected but also those credited to Yucatan by Hemsley, thus forming a starting point for the subsequent exploration of this very interesting flora. Thus far 264 species are recorded from the mainland, and 314 from the adjacent islands.

An invitation to the botanists from Dr. Farlow to visit Cambridge on Saturday in lieu of the general excursion of the A. A. A. S. was accepted by a dozen, who were entertained with lavish hospitality. Under the guidance of Dr. Farlow and Dr. Robinson they visited the botanical laboratories in the Agassiz Museum, the Botanical Garden and Herbarium, and the Arnold Arboretum. They were received by Mrs. Gray at an afternoon tea and shown the first volume of autograph letters of botanists which has been prepared from those received by Dr. Gray, the original drawings by Sprague for the *Genera Illustrata*, an autograph of Linnæus, and various other things of interest to botanists. At the Aboretum, Mr. C. E. Faxon accompanied the party and explained the plans for planting.

WALKER PRIZES IN NATURAL HISTORY.

By the provisions of the will of the late Dr. William Johnson Walker, two prizes are annually offered by the **Boston Society of Natural History** for the best memoirs written in the English language on subjects proposed by a committee appointed by the Council.

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1. In all cases the memoirs are to be based on a considerable body of original and unpublished work, accompanied by a general review of the literature of the subject.

2. Anything in the memoir which shall furnish proof of the identity of the author shall be considered as debarring the essay from competition.

3. Each memoir must be accompanied by a sealed envelope enclosing the author's name and superscribed with a motto corresponding to one borne by the manuscript, and must be in the hands of the Secretary on or before April 1st of the year for which the prize is offered.

Subjects for 1896:

(1) A study of an area of schistose or foliated rocks in the eastern United States.

(2) A study of the development of river valleys in some considerable area of folded or faulted Appalachian structure in Pennsylvania, Virginia, or Tennessee.

(3) An experimental study of the effects of close-fertilization in the case of some plant of short cycle.

(4) Contributions to our knowledge of the general morphology or the general physiology of any animal, except man.

Subjects for 1897:

(1) A study of glacial, fluviatile, or lacustrine phenomena associated with the closing stages of the glacial period.

(2) Original investigations in regard to the chalazal impregnation of any North American species of Angiosperms.

(3) An experimental investigation in cytology.

(4) A contribution to our knowledge of the morphology of the Bacteria.

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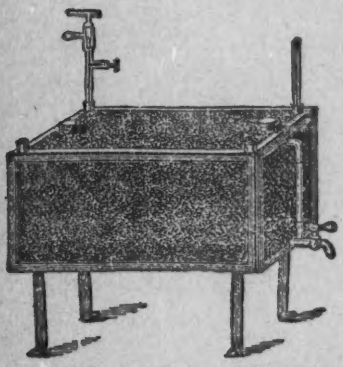

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